

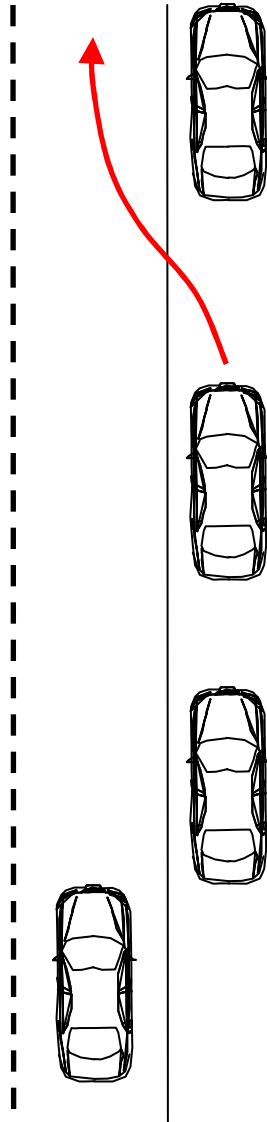
# Objective Data Collection

- Relevant vehicle data:
  - Steering angle, lane position, accelerator pedal position, brake pressure, ...
- Relevant scenario data:
  - IVIS task, Mitigation mode, FCW timing, ...
- Video Data. Quad-split digital video of the drive:
  1. View of the driver from passenger side B-pillar
  2. The forward view of the driving scene
  3. View of the driver's face from the DSM
  4. View of the IVIS screen
  5. View of driver foot well (accelerator/brake pedals)



# Methods: Forward Collision Event

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- Eleven vehicles parked on shoulder
  - Most appropriate vehicle pulls out based on timing of the Mitigation mode
- On-coming traffic level was always set to mid level
  - 47 meters between vehicles (~3.5 sec headway)
  - Mid level traffic density was plausible for all mitigation conditions
  - Kept traffic level constant across conditions to eliminate differences in driver behavior due to different traffic levels
- For drivers doing an IVIS task:
  - Retrieve and read text-message from Julie

# Methods: Forward Collision Event

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- Task Allowed
  - Car pull-out initiated 6 seconds after end of voice-over. (*“Please retrieve and read saved text-message from Julie now”*)
- Task Denied
  - Car pull-out initiated 6 seconds after end of voice-over.
- No Task
  - Car pull-out initiated 6 seconds after end of muted voice-over.
- Task Interrupted
  - Car pull-out initiated shortly after driver touches IVIS screen for text-message task
    - Driver touches IVIS screen
    - IVIS is disabled
    - Car-pull-out initiated (and receives FCW)



# Demo Video

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- Forward Collision event for Interrupted condition



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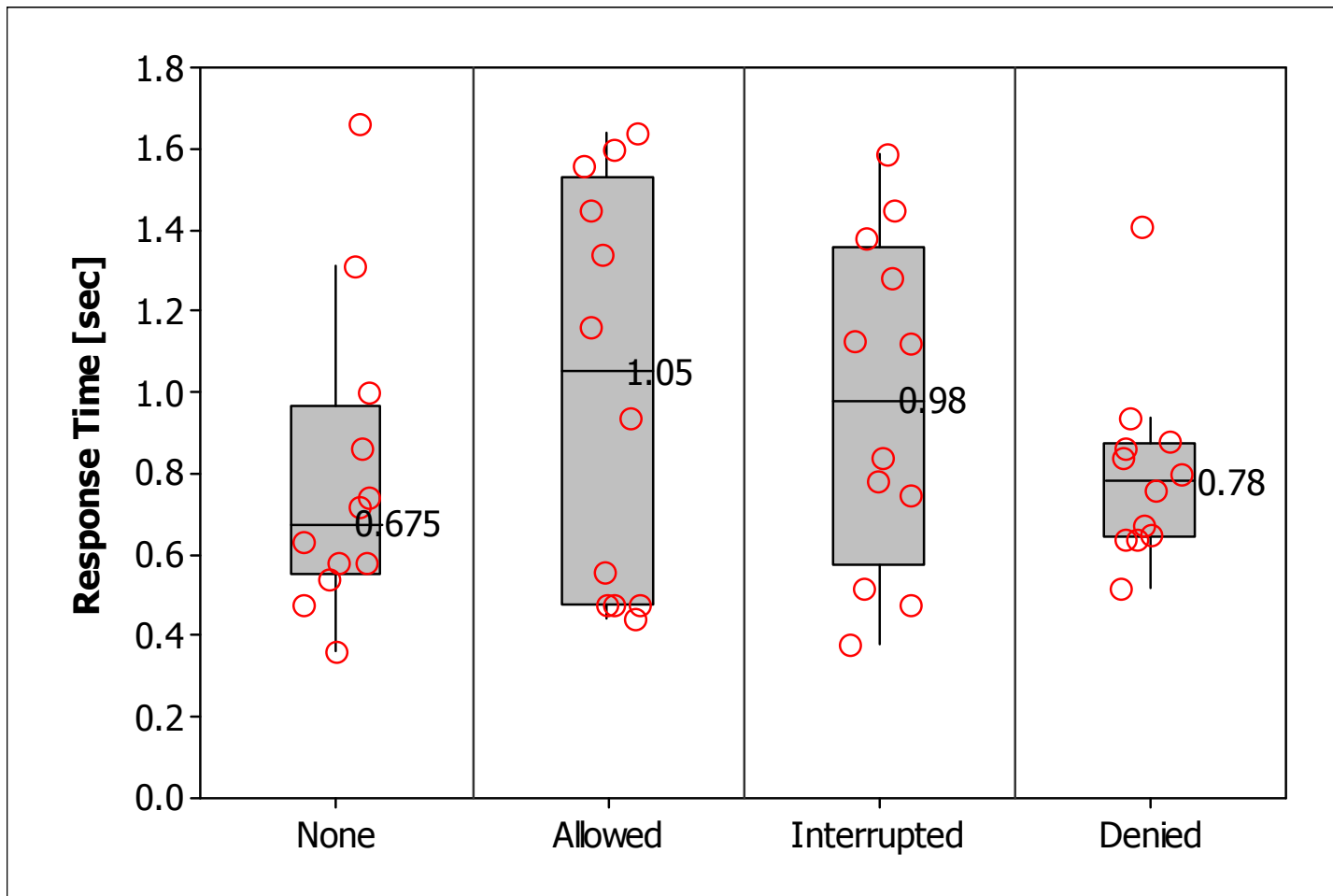
# Results: Analysis of Forward Collision Event

- **Response Time:**
  - Time from **FCW** until **brake onset**
  - CAMP algorithm used to calculate brake onset
- **Reaction Time:**
  - Time from **FCW** until **first foot motion**
  - First foot motion calculated from throttle release...
  - ... or drive videos if driver was coasting

# Results: Analysis of Forward Collision Event

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- **Response Time**: Time from **FCW** until **brake onset**



# Results: Analysis of Forward Collision Event

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## Response Time

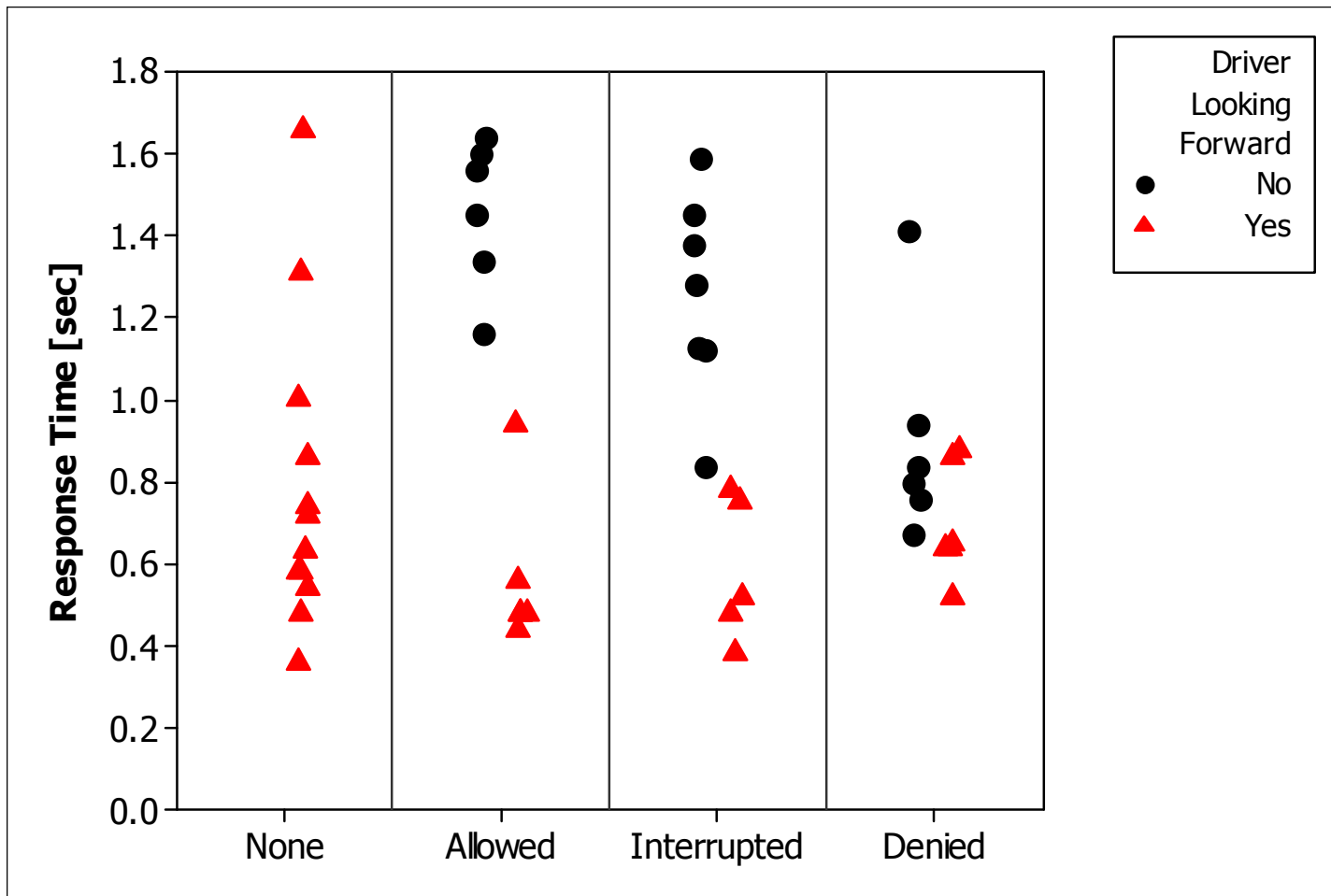
- Central Tendency Results (ANOVA and Kruskal-Wallis)
  - No significance among Mitigation Task types
  - No gender significances
- Distribution Spread Results
  - **No Task** *significantly differs* from **Allowed & Denied**
  - **Allowed** *significantly differs* from **None & Denied**
  - **Interrupted** *significantly differs* from **Denied**
  - **Denied** *significantly differs* from **Allowed & Interrupted**



# Results: Analysis of Forward Collision Event

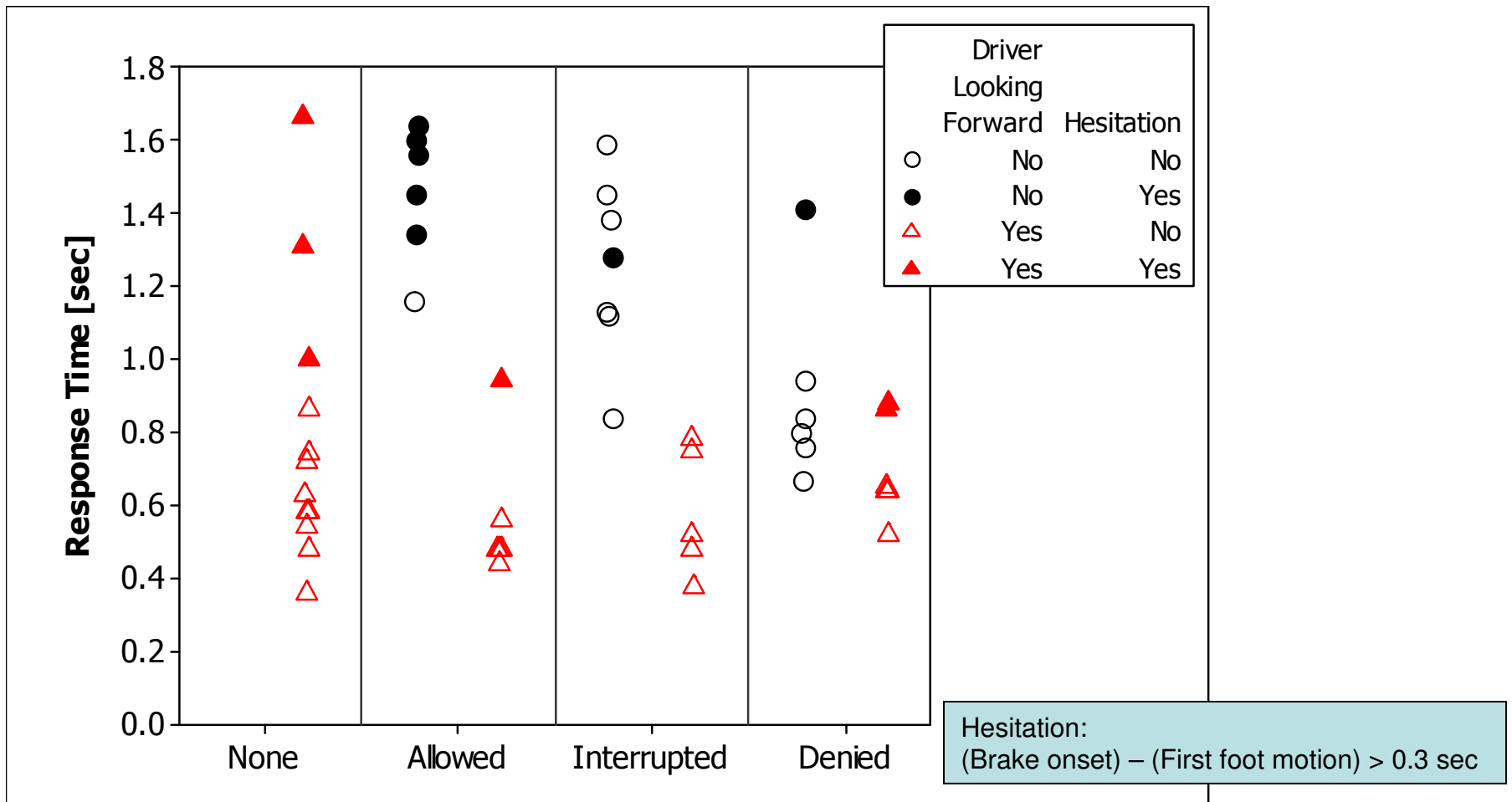
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- **Response Time**: Time from **FCW** until **brake onset**



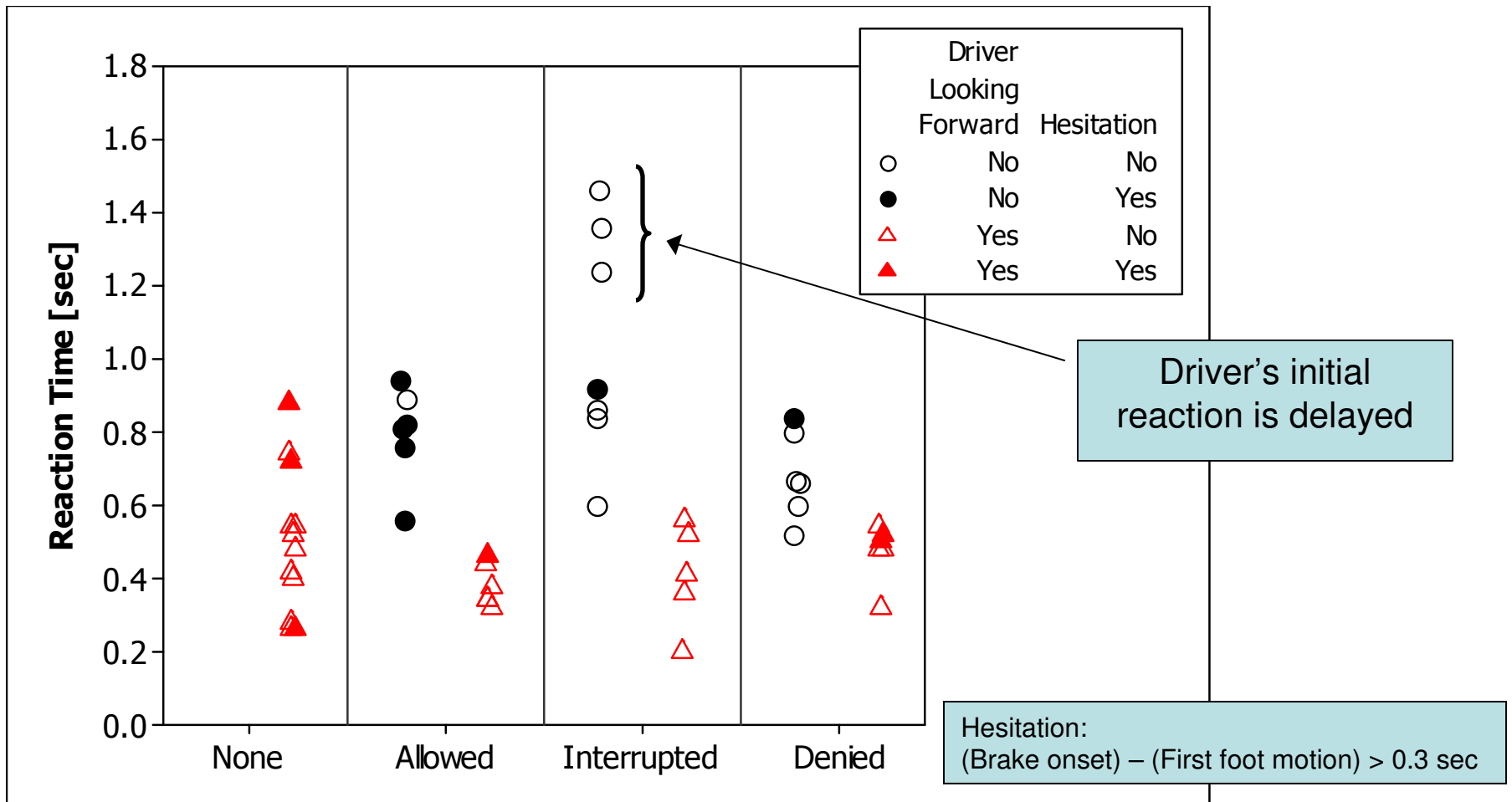
# Results: Analysis of Forward Collision Event

- **Response Time**: Time from **FCW** until **brake onset**



# Results: Analysis of Forward Collision Event

- Reaction Time**: Time from **FCW** until **first foot motion**



# Results: Analysis of Forward Collision Event

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## Reaction Time

- Central Tendency Results (ANOVA and Kruskal-Wallis)
  - No significance among Mitigation Task types
  - No gender significances
- Distribution Spread Results
  - **None** *significantly differs* from **Interrupted**
  - **Allowed** does not *significantly differ* from any other
  - **Interrupted** *significantly differs* from **None & Denied**
  - **Denied** *significantly differs* from **Interrupted**



# Demo Videos

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- Larger Reaction Time for Interrupted condition



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# Summary for Driver and Mitigation system performance

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- None condition
  - All drivers had relatively small Reaction Times
  - All drivers were looking forward when FCW was activated
  - A few drivers hesitated from first foot motion to brake onset as they interpreted the collision event
- Denied condition
  - All drivers had relatively small Reaction Times
  - Relatively tight distribution of Response Time
    - Drivers know they are in a high demand situation, which might sensitize them to potential traffic conflicts



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# Summary for Driver and Mitigation system performance

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- Allowed condition
  - All drivers had relatively small Reaction Times
  - Larger spread in Response Time
    - Corresponds to drivers looking away from forward view when FCW was activated
- Interrupted condition
  - *Most* drivers had relatively small Reaction Times
    - 3 (of 12) drivers had large Reaction Times
    - Due to additional cognitive delay of interpreting denied task AND forward collision event???



# Summary for Driver and Mitigation system performance

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- Overall for forward collision event
  - Based on Response Times, the Mitigation system does not appear to add additional delay.
    - Denied condition has tight distribution
  - Based on Reaction Times
    - Might be some additional cognitive delay associated with the Interrupted condition for some drivers.
      - Merits additional investigation



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# Summary for Driver and Mitigation system performance

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- Interrupted condition
  - All drivers reacted quickly
  - Relatively tight distribution of Response Time
    - Only one driver hesitated from first foot motion to brake onset
    - Drivers know they are in a high demand situation, which might sensitize them to potential traffic conflicts



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# Determination of Hesitation Threshold

**Driver Delay between 1st foot motion and brake onset**

